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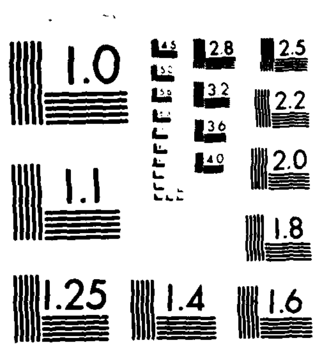

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Interactive Spline Modelling

FINAL REPORT

Elaine Cohen

27 April 1983

U. S. Army Research Office

Contract Number DAAG2982K0176

Computer Science
University of Utah

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This contract has initiated explorations into the advantages of interactive environments for developing computer based spline representations and the types of moderately complex objects for which it might be suitable. Additionally mathematical tools for surface fitting and modification in an interactive environment are investigated in the context of modelling a helicopter in this environment.

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1. Statement of Problem

At the current state-of-affairs in computer aided geometric design (CAGD) there is a considerable capability for representing mathematically the shape of various objects of interest in terms of piecewise formulations like polynomial spline functions. Approximation and interpolation conditions can be met within the same surface description. Moreover discontinuities can be embedded within the same general representations by using multiple knots. A major difficulty in producing more complex objects is the lack of a suitable tool for the user to specify or quantify this information.

Increasingly it is being realized that a useful system for designing or specifying geometric objects requires algorithmic power, in addition to the obvious graphical extensions. CAGD history holds many examples of particular efforts that have been motivated by the need for the graphical extensions without the necessary native algorithmic power. Without the algorithmic base, the systems are entirely special purpose and restricted only to the particular applications spanned by the foresight of the original systems architect.

There are other areas where extensibility and flexibility are paramount. Design is a highly idiosyncratic activity. An idiom or paradigm which is very comfortable, that is intuitive and natural, for one user or group of users from a particular discipline might be wholly rejected by another. A new syntax may be appropriate for the very same underlying semantics. Or an alternative set of primitive expressions might be the secret to having the approach become acceptable to a new community of potential users. In a fixed and compiled environment this kind of accommodation entails major rewriting, and makes incremental adjustments difficult.

It may seem curious that, while the case for interactive computer graphics and computer aided geometric design has frequently been made and already widely accepted, the programming environments which are invoked for such purposes are nearly always compiled (and therefore fixed) languages. An interpretive mode in which the user indicates a construction and can immediately observe the effects of his commands are much closer to the notion of true user interaction. Instead of compiling a complex and intricate set of commands, the user ought to have the access to an interpretive environment which supports this kind of design with the flexibility and interaction of an interpreter.

Under this contract we have sought to gain some experimental understanding about the applicability of a LISP based environment to the modelling requirements of the CAGD project. This involves adding the necessary graphics primitives and developing a few paradigms for using PSL within the framework of CAGD work.

2. Summary of Results

This research has used the experimental modelling system under development in Computer Science, the Alpha_1 system, as its experimental testbed. By interfacing to and interacting with other ongoing research the investigators had the benefit of the leverage accorded by a extensive environment. A significant portion of the research effort was committed to modelling efforts, since that is the genuine test for an approach toward establishing an interactive modelling environment.

Modelling a helicopter was the project chosen selected because it incorporated many difficult, but typical modelling problems. In the general setting, these problems are generic of many occurring in practice. Thus it was chosen to serve as a research target for developing appropriate tools for realizing this model. The modelling task required developing a collection of mathematical tools to be available in the interactive design process.

The model was to be developed using parametric tensor product spline surfaces. The paradym used most heavily would be generalized lofting. That is, to determine station, or section, curves in one parametric direction and then to blend them according to some criteria in the other parametric direction. It was decided that capabilities to digitize, approximate according to sets of rules, and interpolate according to sets of rules interactively would add flexibility to the exploration. Selective enforcement of symmetry constraints would ease the digitization process. Further, the selected model had closed periodic section data and the tools should take advantage of this.

The approximation tools built allowed the user to specify a (periodic) least squares fit to the data. Least squares is sensitive to selection of knot values, data parametrization, curve degree, and the relative number of data points between knots, as well as their location. This implementation automatically calculated a parametrization, but left the user the flexibility to experiment with what degree polyomial splines to use, where and what multiplicity the knots should have, and which data points should be used to calculate the approximation.

Another approximation method, which could be used in the same design session, perhaps for refinement of the fit, allowed parameter modification as well as modification of the aforementioned variables. The designer could initiate a new fit to a section or modify the result of a last iteration. In both methods, multiple sections of data and their curve representations could be viewed simultaneously.

The lofting operation used spline interpolation. Since the user might want to compare several different interpolating splines with different continuity conditions at the knots, a spline interpolation capability was developed which allowed more degrees of freedom than found in typical standard spline interpolation. In rapidly changing areas, this property allowed trade off of higher degree continuity class against fewer undulations and more control.

The implementation of these mathematical techniques within the framework of a powerful interactive language with the aid of graphics has several advantages. First of all, it was implemented in a Lisp-like environment which is fully interpretive and therefore supports interactive modelling. Results are immediately available on a stepwise basis, so any mistakes are detected early and can be corrected as the step is being carried out. This greatly simplified and expedited the modelling and debugging process. It provided feedback in a short enough time to be very helpful for generating good intuition about the overall modelling process. Moreover this environment provided excellent data structures as a natural consequence.

Essentially this work concludes positively that the discussed features of the lisp-like environment together with the powerful capability for expressing the necessary mathematical functions required for the task of modelling something like the helicopter make this approach seem sound and beneficial.

REFERENCES

[1] Cohen, Elaine.
Some Mathematical Tools for a Modeller's Workbench.
In Proceedings of the Symposium on Computer Aided Geometry Modelling. NASA Conference, Langley, VA , 1983.

[2] Riesenfeld, Richard F.
Computer Aided (Geometric) Design Education in the CS Department.
In Proceedings of Conf on University Programs in Computer Aided Engineering, Design, and Manufacturing. BYU, Provo, Utah, 1983.
Presented to the BYU conference, April 1983.

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